

6 JULY 2009

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.: 10/649,214

Filing Date: August 26, 2003

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Group Art Unit: 3737

Examiner: Parikha Solanki Mehta

Title: METHOD AND APPARATUS FOR
ELECTROMAGNETIC NAVIGATION OF A
SURGICAL PROBE NEAR A METAL OBJECT

Attorney Docket: 5074A-000001/COB

discussion only

AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions and listings of claims in the application.

LISTING OF CLAIMS

1. - 26. (Cancelled)

27. (Previously Presented) An electromagnetic navigation system for use in navigating an instrument through an electromagnetic field positioned near a metal object, said electromagnetic navigation system comprising:

- (a) an instrument navigable in an electromagnetic field;
- (b) a transmitter coil array having a plurality of transmitter coils that generates the electromagnetic field to navigate the instrument; and
- (c) a shield ~~adapted to be~~ positioned adjacent the metal object that shields the metal object from the electromagnetic field generated by said transmitter coil array to create a virtual surface or infinite plane to reflect or shield the metal object, said shield having a conically shaped portion that extends outwardly from a mounting mechanism, said transmitter coil array attached to said shield, wherein said shield substantially reduces distortion of the electromagnetic field caused by the metal object, ~~thereby enabling accurate navigation of the instrument in the electromagnetic field, wherein reflecting or shielding of these fields prevents field distortion, and thus prevents disturbances~~ by objects on the opposite side of the shield.

28. (Original) The electromagnetic navigation system as defined in Claim 27 wherein said transmitter coil array is integrally formed transmitting coils positioned about a perimeter of said shield.

29. (Original) The electromagnetic navigation system as defined in Claim 27 wherein said transmitter coil array is displaced from said shield.

30. (Original) The electromagnetic navigation system as defined in Claim 29, wherein said transmitter coil array includes at least three sets of transmitter coils which are displaced from said shield.

31. (Original) The electromagnetic navigation system as defined in Claim 30 wherein said three sets of transmitter coils are displaced from said shield by an extension member.

32. (Previously Presented) The electromagnetic navigation system as defined in Claim 30, wherein each set of transmitter coils includes three coils positioned orthogonal to one another.

33. (Previously Presented) The electromagnetic navigation system as defined in Claim 27 further comprising a controller that drives said transmitter coil array in at least one of a time division multiplexed manner, a frequency division multiplexed manner or a combination of both.

34. (Original) The electromagnetic navigation system as defined in Claim 27 wherein the metal object is a fluoroscope.

35. (Original) The electromagnetic navigation system as defined in Claim 34 wherein said fluoroscope is a C-arm fluoroscope.

36. (Original) The electromagnetic navigation system as defined in Claim 27 wherein at least one of said shield and transmitter coil array is removably attached to said metal object.

37. (Original) The electromagnetic navigation system as defined in Claim 34 wherein said shield is integral with said fluoroscope.

38. (Original) The electromagnetic navigation system as defined in Claim 27 wherein said instrument includes at least one electromagnetic sensor attached at a distal end of said instrument.

39. (Previously Presented) The electromagnetic navigation system as defined in Claim 38 wherein said instrument is non-rigid and may bend during navigation and said instrument includes a plurality of electromagnetic sensors to provide further location information regarding said instrument.

40. (Original) The electromagnetic navigation system as defined in Claim 27 wherein said transmitter coil array is controlled over a wireless channel.

41. (Original) The electromagnetic navigation system as defined in Claim 27 wherein said instrument operates over a wireless channel.

42. (Original) The electromagnetic navigation system as defined in Claim 27 wherein the field strength of each coil in the transmitter coil array is stored on a memory medium where each field strengths takes into account interference from the metal object.

43. (Original) The electromagnetic navigation system as defined in Claim 42 wherein the memory medium is a flash ROM.

44. (Previously Presented) An electromagnetic navigation system for use in navigating an instrument through an electromagnetic field positioned near a fluoroscope that includes an intensifier tube, said electromagnetic navigation system comprising:

- (a) an instrument navigable in an electromagnetic field;
- (b) a transmitter coil array having a plurality of transmitter coils, said transmitter coil array generates the electromagnetic field to navigate the instrument; and
- (c) a shield adapted to be attached about a circumference of the intensifier tube, said shield being conically shaped to extend outwardly from said circumference of said intensifier tube, said shield substantially shields the fluoroscope from the electromagnetic field generated by said transmitter coil array, wherein said shield substantially reduces distortion of the electromagnetic field by the fluoroscope, thereby enabling accurate navigation of the instrument in the electromagnetic field.

45. (Original) The electromagnetic navigation system as defined in Claim 44 wherein at least one of said transmitter coil array is integrally formed transmitting coils positioned about a perimeter of said shield.

46. (Original) The electromagnetic navigation system as defined in Claim 44 wherein said transmitter coil array is displaced from said shield.

47. (Original) The electromagnetic navigation system as defined in Claim 46 wherein said transmitter coil array includes at least three sets of transmitter coils which are displaced from said shield.

48. (Original) The electromagnetic navigation system as defined in Claim 47 wherein said three sets of transmitter coils are displaced from said shield by an extension member.

49. (Previously Presented) The electromagnetic navigation system as defined in Claim 48 wherein each set of transmitter coils includes three sets of coils positioned orthogonal to one another.

50. (Original) The electromagnetic navigation system as defined in Claim 44 wherein said transmitter coil array is driven in at least one of a time division multiplexed manner, frequency division multiplexed manner or a combination of both.

51. – 53. (Cancelled)

54. (Previously Presented) An electromagnetic navigation system for use in navigating an instrument through an electromagnetic field formed near a metal object, said electromagnetic navigation system comprising:

- (a) a surgical instrument navigable in an electromagnetic field;
- (b) a transmitter coil that generates the electromagnetic field to navigate the surgical instrument; and
- (c) a shield adapted to be positioned about the metal object that substantially shields the metal object from the electromagnetic field generated by said transmitter coil, said shield being conically shaped to extend outwardly from a mounting mechanism, said shield defining one or more openings about a perimeter of said shield, wherein the shield substantially reduces distortion of the electromagnetic field by the metal object, wherein the surgical instrument is operable to be navigated in the electromagnetic field.

55. (Previously Presented) The electromagnetic navigation system as defined in Claim 54, wherein said transmitter coil is attached to said shield.

56. (Previously Presented) The electromagnetic navigation system as defined in Claim 54, wherein said transmitter coil is a transmitter coil array including a plurality of transmitter coils.

57. (Previously Presented) The electromagnetic navigation system as defined in Claim 54, wherein the transmitter coil array includes three sets of coils.

58. (Previously Presented) The electromagnetic navigation system as defined in Claim 57, wherein each of the sets of coils includes three transmitter coils.

58. (Cancelled)

60. (Previously Presented) The electromagnetic navigation system as defined in Claim 54,
wherein said surgical instrument is operable to be accurately navigated in the electromagnetic field at least in part because of said shield.

61. (Previously Presented) The electromagnetic navigation system as defined in Claim 54, wherein said transmitter coil is integrally formed with said shield.

62. (Previously Presented) The electromagnetic navigation system as defined in Claim 54, wherein said transmitter coil is displaced from said shield.

63. (Previously Presented) The electromagnetic navigation system as defined in Claim 54, wherein the metal object is at least one of an operating room table, a fluoroscope, a microscope, an ultrasound hand piece, a high-intensity focused ultrasound systems, a computer topography (CT) imaging system, an interoperative computer topography, a magnetic resonance imaging (MR) system, an interoperative magnetic resonance, a surgical robot, or combinations thereof.

64. (Previously Presented) The electromagnetic navigation system as defined in Claim 60, wherein the surgical instrument further comprises at least one of a surgical probe, a catheter, a steerable catheter, an endoscope, a shunt, a drill guide, an awl/tap, an orthopedic instrument, or a combination thereof.

65. (Previously Presented) The electromagnetic navigation system as defined in Claim 54, further comprising:

a transmitter coil controller having at least one of a wireless receiver, wireless transmitter, or combinations thereof associated with the transmitter coil controller; and

at least one of a wireless receiver, wireless transmitter, or combinations thereof associated with the transmitter coil;

wherein a wireless communication channel is used to communicate between the transmitter coil controller and the transmitter coil;

wherein the operation of the transmitter coil array is controlled via the wireless communication channel.

66. (Previously Presented) The electromagnetic navigation system as defined in Claim 54, further comprising:

an instrument interface having at least one of a wireless receiver, wireless transmitter, or combinations thereof associated with said instrument interface;

at least one of a wireless receiver, wireless transmitter, or combinations thereof associated with the surgical instrument;

wherein a wireless communication channel is used to communicate between the instrument interface and surgical instrument;

wherein information is transmitter via the wireless communication channel.

67. (Previously Presented) The electromagnetic navigation system as defined in Claim 66, further comprising:

a display operable to display navigation information.

68. (Canceled)

69. (Previously Presented) The electromagnetic navigation system as defined in Claim 54, wherein the shield comprises a conductive or semi-conductive material.

70. (Previously Presented) An electromagnetic navigation system for use in navigating an instrument through a field formed near an interfering object, said electromagnetic navigation system comprising:

- (a) an instrument navigable in the field;
- (b) a transmitter array including a plurality of transmitter coils, wherein each of the transmitter coils generates at least a portion of the field to be used to navigate the instrument; and
- (c) a shield adapted to be positioned about the interfering object to substantially shield the interfering object from the field generated by said transmitter coil, said shield defining a plurality of openings spaced about a perimeter of said shield, wherein the shield substantially reduces distortion of the field by the interfering object.

71. (Previously Presented) The electromagnetic navigation system as defined in Claim 70, wherein the field includes an electromagnetic field, a magnetic field, or combinations thereof.

72. (Previously Presented) The electromagnetic navigation system as defined in Claim 70, wherein said transmitter coil is attached to said shield.

73. (Previously Presented) The electromagnetic navigation system as defined in Claim 70, wherein the transmitter coil array includes three sets of coils.

74. (Previously Presented) The electromagnetic navigation system as defined in 70, wherein the transmitter coil array includes a plurality of transmitter coils each oriented along a different axis.

75. (Previously Presented) The electromagnetic navigation system as defined in Claim 70, wherein said transmitter coil array is at least one of integrally formed with said shield, positioned a distance from said shield, or combinations thereof.

76. (Previously Presented) The electromagnetic navigation system as defined in Claim 70, wherein the interfering object is at least one of an operating room table, a fluoroscope, a microscope, an ultrasound hand piece, a high-intensity focused ultrasound systems, a computer topography (CT) imaging system, an interoperative computer topography, a magnetic resonance imaging (MR) system, an interoperative magnetic resonance, a surgical robot, or combinations thereof.

77. (Previously Presented) The electromagnetic navigation system as defined in Claim 70, wherein the instrument is at least one of a surgical probe, a catheter, a steerable catheter, an endoscope, a shunt, a drill guide, an awl/tap, an orthopedic instrument, or a combination thereof.

78. (Previously Presented) The electromagnetic navigation system as defined in Claim 70, further comprising:

a transmitter coil array controller having at least one of a wireless receiver, wireless transmitter, or combinations thereof associated with the transmitter coil controller; and

at least one of a wireless receiver, wireless transmitter, or combinations thereof associated with the transmitter coil;

wherein a wireless communication channel is used to communicate between the transmitter coil controller and the transmitter coil;

wherein the operation of the transmitter coil array is controlled via the wireless communication channel.

79. (Previously Presented) The electromagnetic navigation system as defined in Claim 70, further comprising:

an instrument interface having at least one of a wireless receiver, wireless transmitter, or combinations thereof associated with said instrument interface;

at least one of a wireless receiver, wireless transmitter, or combinations thereof associated with the instrument;

wherein a wireless communication channel is used to communicate between the instrument interface and instrument;

wherein information is transmitter via the wireless communication channel.

80. (Previously Presented) The electromagnetic navigation system as defined in Claim 70, further comprising:

a display operable to display navigation information.

81. (Previously Presented) The electromagnetic navigation system as defined in Claim 70, wherein said shield comprises a conductive or semi-conductive material.

82. (Previously Presented) The electromagnetic navigation system as defined in 70, wherein the shield is positioned between the instrument and the interfering object.

83. (Previously Presented) The electromagnetic navigation system as defined in 70, further comprising:

a calibration sensor operable to measure the field and determine a position of the calibration sensor relative to an origin.

84. (Previously Presented) The electromagnetic navigation system of Claim 83, wherein the calibration sensor is interconnected with a robotic unit to determine the position of the calibration sensor relative to the origin.

85. (Previously Presented) The electromagnetic navigation system as defined in Claim 56, wherein the transmitter coil array includes a plurality of transmitter coils each oriented along a different axis.

86. (Previously Presented) The electromagnetic navigation system as defined in Claim 54, wherein said mounting mechanism comprises an annular clamp.

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